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Report on the individual review of the annual submission of Luxembourg submitted in 2014*

* In the symbol for this document, 2014 refers to the year in which the inventory was submitted, and not to the year of publication.

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I. Introduction and summary

1. This report covers the review of the 2014 annual submission of Luxembourg, coordinated by the UNFCCC secretariat, in accordance with the "Guidelines for review under Article 8 of the Kyoto Protocol" (decision 22/CMP.1) (hereinafter referred to as the Article 8 review guidelines). The review took place from 15 to 20 September 2014 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Mr. Newton Paciornik (Brazil) and Ms. Melissa Weitz (United States of America); energy – Mr. Leonidas Girardin (Argentina), Ms. Gherghita Nicodim (Romania) and Mr. Anand Sookun (Mauritius); industrial processes and solvent and other product use – Mr. Erhan Unal (Turkey) and Ms. Sina Wartmann (Germany); agriculture – Mr. Paul Duffy (Ireland), Mr. Bernard Hyde (Ireland) and Mr. Yuriy Pyrozhenko (Ukraine); land use, land-use change and forestry (LULUCF) – Mr. Valentin Bellassen (France), Mr. Zoltan Somogyi (Hungary) and Ms. Diana Vargas (Colombia); and waste – Ms. Maryna Bereznytska (Ukraine) and Ms. Riitta Pipatti (Finland). Ms. Bereznytska and Mr. Paciornik were the lead reviewers. The review was coordinated by Mr. Roman Payo (UNFCCC secretariat).

2. In accordance with the Article 8 review guidelines, a draft version of this report was sent to the Government of Luxembourg, which provided comments that were considered and incorporated, as appropriate, into this final version of the report. All encouragements and recommendations in this report are for the next annual submission, unless otherwise specified.

3. All recommendations and encouragements included in this report are based on the expert review team's (ERT's) assessment of the 2014 annual submission against the Article 8 review guidelines. The ERT has not taken into account the fact that Parties will prepare the submissions due by 15 April 2015 using the revised "Guidelines for the preparation of national communications by Parties include in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories" adopted through decision 24/CP.19. Therefore, when preparing the next annual submissions, Parties should evaluate the implementation of the recommendations and encouragements in this report, in the context of those guidelines.

4. In 2012, the main greenhouse gas (GHG) emitted by Luxembourg was carbon dioxide (CO_2), accounting for 91.8 per cent of total GHG emissions[1] expressed in carbon dioxide equivalent (CO_2 eq), followed by nitrous oxide (N_2O) (3.9 per cent) and methane (CH_4) (3.6 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 0.6 per cent of the overall GHG emissions in the country. The energy sector accounted for 88.7 per cent of total GHG emissions, followed by the agriculture sector (5.6 per cent), the industrial processes sector (5.2 per cent), the waste sector (0.4 per cent) and the solvent and other product use sector (0.1 per cent). Total GHG emissions amounted to 11,838.19 Gg CO_2 eq and decreased by 8.3 per cent between the base year[2] and 2012. The ERT concluded that the description in the national inventory report (NIR) of the trends for the different gases and sectors is reasonable.

[1] In this report, the term "total GHG emissions" refers to the aggregated national GHG emissions expressed in terms of carbon dioxide equivalent excluding LULUCF, unless otherwise specified.

[2] "Base year" refers to the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs and SF_6. The base year emissions include emissions from sources included in Annex A to the Kyoto Protocol only.

5. Tables 1 and 2 show GHG emissions from sources included in Annex A to the Kyoto Protocol (hereinafter referred to as Annex A sources), emissions and removals from the LULUCF sector under the Convention and emissions and removals from activities under Article 3, paragraph 3, and, if any, elected activities under Article 3, paragraph 4, of the Kyoto Protocol (KP-LULUCF), by gas and by sector and activity, respectively.

6. Information to be included in the compilation and accounting database can be found in annex I to this report.

II. Technical assessment of the annual submission

A. Overview

1. Annual submission and other sources of information

7. The 2014 annual submission was submitted on 15 April 2014; it contains a complete set of common reporting format (CRF) tables for the period 1990–2012 and an NIR. Luxembourg submitted a revised NIR on 22 May 2014. Luxembourg also submitted the information required under Article 7, paragraph 1, of the Kyoto Protocol, including information on: activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, accounting of Kyoto Protocol units, changes in the national system and in the national registry and the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol. The standard electronic format (SEF) tables were submitted on 15 April 2014. The annual submission was submitted in accordance with decision 15/CMP.1.

8. Luxembourg submitted revised emission estimates on 7 November 2014 and on 17 November 2014 in response to the list of potential problems and further questions raised by the ERT (see paras. 49, 52 and 87–91 below). The values used in this report are those submitted by Luxembourg on 17 November 2014.

9. The list of other materials used during the review is provided in annex II to this report.

2. Questions of implementation raised in the 2013 annual review report

10. The ERT noted that no questions of implementation have been raised in the 2013 annual review report.

Table 1

Greenhouse gas emissions from Annex A sources and emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol by gas, base year[a] to 2012

			Gg CO_2 eq								*Change (%)*
		Greenhouse gas	*Base year*	*1990*	*1995*	*2008*	*2009*	*2010*	*2011*	*2012*	*Base year–2012*
Annex A sources		CO_2	11 950.29	11 950.29	9 210.08	11 207.20	10 703.32	11 255.14	11 138.34	10 870.11	–9.0
		CH_4	462.45	462.45	470.44	446.76	444.34	451.07	434.15	427.12	–7.6
		N_2O	476.62	476.62	479.83	475.19	469.58	480.22	480.68	465.39	–2.4
		HFCs	15.59	12.01	15.59	63.46	65.47	66.47	67.01	67.26	331.5
		PFCs	NA, NO	NA, NO	NA, NO	0.24	0.22	0.20	0.18	0.16	NA
		SF_6	1.55	1.13	1.55	6.57	7.00	7.39	7.75	8.14	423.8
KP-LULUCF	Article 3.3[b]	CO_2				–57.76	–57.99	–72.49	–86.99	–101.49	
		CH_4				NO	NO	NO	NO	NO	
		N_2O				0.75	0.76	0.70	0.64	0.58	
	Article 3.4[c]	CO_2	NA			NA	NA	NA	NA	NA	NA
		CH_4	NA			NA	NA	NA	NA	NA	NA
		N_2O	NA			NA	NA	NA	NA	NA	NA

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable, NO = not occurring.

[a] The base year for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs and SF_6. The base year for cropland management, grazing land management and revegetation under Article 3, paragraph 4, of the Kyoto Protocol is 1990. For activities under Article 3, paragraph 3, of the Kyoto Protocol and forest management under Article 3, paragraph 4, only the inventory years of the commitment period must be reported.

[b] Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation.

[c] Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation.

Table 2
Greenhouse gas emissions by sector and activity, base year[a] to 2012

			Gg CO_2eq								*Change (%)*
		Sector	*Base year*	*1990*	*1995*	*2008*	*2009*	*2010*	*2011*	*2012*	*Base year–2012*
Annex A sources		Energy	10 429.97	10 429.97	8 340.93	10 736.43	10 291.99	10 836.57	10 702.85	10 496.36	0.6
		Industrial processes	1 625.50	1 621.50	1 001.64	705.99	641.50	660.24	671.51	610.74	–62.4
		Solvent and other product use	23.90	23.90	19.70	16.72	15.51	13.45	13.82	12.17	–49.1
		Agriculture	744.66	744.66	734.70	673.85	677.78	690.00	684.16	668.68	–10.2
		Waste	82.48	82.48	80.52	66.44	63.15	60.22	55.78	50.24	–39.1
		LULUCF	NA	331.61	–254.24	–400.89	–429.29	–432.43	–434.97	–438.03	NA
		Total (with LULUCF)	**NA**	**13 234.12**	**9 923.25**	**11 798.54**	**11 260.62**	**11 828.05**	**11 693.15**	**11 400.16**	**NA**
		Total (without LULUCF)	**12 906.51**	**12 902.50**	**10 177.48**	**12 199.43**	**11 689.92**	**12 260.48**	**12 128.12**	**11 838.19**	**–8.3**
		Other[b]	NA	NA	NA	NA	NA	NA	NA	NA	NA
KP-LULUCF	Article 3.3[c]	Afforestation and reforestation				–105.84	–106.32	–118.87	–131.41	–143.96	
		Deforestation				48.83	49.09	47.08	45.07	43.06	
		Total (3.3)				**–57.01**	**–57.23**	**–71.79**	**–86.35**	**–100.90**	
	Article 3.4[d]	Forest management				NA	NA	NA	NA	NA	
		Cropland management	NA			NA	NA	NA	NA	NA	NA
		Grazing land management	NA			NA	NA	NA	NA	NA	NA
		Revegetation	NA			NA	NA	NA	NA	NA	NA
		Total (3.4)	**NA**			**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use, land-use change and forestry, NA = not applicable.

[a] The base year for Annex A sources is the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs and SF_6. The base year for cropland management, grazing land management and revegetation under Article 3, paragraph 4, of the Kyoto Protocol is 1990. For activities under Article 3, paragraph 3, of the Kyoto Protocol and forest management under Article 3, paragraph 4, only the inventory years of the commitment period must be reported.

[b] Emissions/removals reported in the sector other (sector 7) are not included in Annex A to the Kyoto Protocol and are therefore not included in national totals.

[c] Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation.

[d] Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation.

3. Overall assessment of the inventory

11. Table 3 contains the ERT's overall assessment of the annual submission of Luxembourg. For recommendations for improvements for specific categories, please see the paragraphs cross-referenced in the table.

Table 3
The expert review team's overall assessment of the annual submission

Issue	*ERT assessment*	*General findings and recommendations*
The ERT's findings on completeness		
Annex A sources[a]	Complete	Mandatory: none
		Non-mandatory: "NE" is reported for potential emissions of HFCs from refrigeration and air-conditioning equipment, foam blowing and aerosols/metered dose inhalers; potential emissions of SF_6 from electrical equipment; CH_4 emissions from enteric fermentation – other (poultry); and CH_4 emissions from direct soil emissions and indirect soil emissions under agricultural soils
		The ERT encourages Luxembourg to estimate and report emissions from all non-mandatory categories
Land use, land-use change and forestry[a]	Complete	Mandatory: none
		Non-mandatory: "NE" is reported for the carbon stock changes in living biomass, dead organic matter and soils for wetlands remaining wetlands and settlements remaining settlements; CO_2, CH_4 and N_2O emissions from biomass burning on settlements; and CO_2, CH_4 and N_2O emissions from harvested wood products
		The ERT encourages Luxembourg to estimate and report emissions from all non-mandatory categories
KP-LULUCF	Complete	
The ERT's findings on recalculations and time-series consistency		
Transparency of recalculations	Sufficiently transparent	Please see paragraphs 25 and 38 below for category-specific findings
Time-series consistency	Sufficiently consistent	Please see paragraphs 40 and 46 below for category-specific findings
The ERT's findings on QA/QC procedures	Sufficient	Luxembourg has elaborated a QA/QC plan and has implemented tier 1 QA/QC procedures in accordance with that plan. Please see paragraphs 14, 26, 30, 38 and 59 below for category-specific recommendations
The ERT's findings on transparency	Sufficiently transparent	Please see paragraphs 25, 31, 33, 35, 43, 58, 60, 64, 83 and 86 below for category-specific recommendations

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, ERT = expert review team, KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NE = not estimated, QA/QC = quality assurance/quality control.

[a] The assessment of completeness by the ERT considers only the completeness of reporting of mandatory categories (i.e. categories for which methods and default emission factors are provided in the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* or the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*).

4. Description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

Inventory planning

12. The NIR and additional information provided by Luxembourg during the review described the national system for the preparation of the inventory. As indicated by Luxembourg in its NIR, there were no changes to the inventory planning process. The description of the inventory planning process, as contained in the report of the individual review of the annual submission of Luxembourg submitted in 2013,[3] remains relevant.

13. Luxembourg included an update in the NIR on its efforts to increase staffing for inventory development. As stated in chapter 13 of the NIR (page 475), the inventory team has been reinforced by two experts.

14. Luxembourg has elaborated a quality assurance/quality control (QA/QC) plan, and has ensured capacity for timely performance of the QA/QC procedures. However, the ERT identified several inconsistencies between the CRF tables and the NIR that indicate issues with the QA/QC process. For example, solid waste disposal sites is listed as a key category by trend assessment for 2012 in the NIR, but is not identified as such in the CRF tables. The uncertainty values noted on page 81 of the NIR are incorrect and have not been updated with the latest results for uncertainty. The ERT recommends that the Party address these issues and improve the effectiveness of its QA/QC procedures.

Inventory preparation

15. Table 4 contains the ERT's assessment of Luxembourg's inventory preparation process. For improvements related to specific categories, please see the paragraphs cross-referenced in the table.

Table 4
Assessment of inventory preparation by Luxembourg

Issue	*ERT assessment*	*ERT findings and recommendations*
Key category analysis		
Was the key category analysis performed in accordance with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF?	Yes	Level and trend analysis performed, including and excluding LULUCF
Approach followed?	Tier 1	
Were additional key categories identified using a qualitative approach?	No	

[3] FCCC/ARR/2013/LUX, paragraphs 10–11.

Issue	*ERT assessment*	*ERT findings and recommendations*
Has Luxembourg identified key categories for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol following the guidance on establishing the relationship between the activities under the Kyoto Protocol and the associated key categories in the UNFCCC inventory?	Yes	Luxembourg followed the guidance. None of the mandatory Article 3, paragraph 3, activities Luxembourg opted for are identified as key according to the quantitative analysis
Does Luxembourg use the key category analysis to prioritize inventory improvements?	Yes	
Assessment of uncertainty analysis		
Approach followed?	Both tier 1 and tier 2	Compared with the previous submission, only the tier 1 uncertainty analysis has been updated. The tier 2 analysis (last conducted in 2011) will be updated in a future submission, as no important methodological changes have been implemented in the inventory. Luxembourg includes only key categories in its tier 1 uncertainty analysis
Was the uncertainty analysis carried out in accordance with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF?	No	See paragraph 16 below
Quantitative uncertainty (including LULUCF)	Level = 3.6% (tier 1) and 4.6% (tier 2) Trend = 3.2% (tier 1) and 3.1% (tier 2)	
Quantitative uncertainty (excluding LULUCF)	Level = 2.5% (tier 1) Trend = 0.9% (tier 1)	

Abbreviations: ERT = expert review team, IPCC good practice guidance = the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, IPCC good practice guidance for LULUCF = IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, LULUCF = land use, land-use change and forestry.

16. The uncertainty analysis was performed using the key categories only, except for the LULUCF sector where the assessment was made only for forest land (see para. 60 below). This is not in line with the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance). The ERT reiterates the recommendation made in the previous review report that Luxembourg include all categories in its uncertainty analysis. The calculated uncertainty is very low compared with the Party's neighbouring countries (5.53 per cent (level) for Belgium, 19.2 per cent (level) for France and 6.1 per cent (level) for Germany). Luxembourg attributes the relatively low uncertainty to relatively high energy consumption (with more certain emission factors (EFs) and activity data (AD) than in other sectors) and emission density, compared with other reporting Parties. Another contributing factor could be the omission of non-key categories that might have relatively high uncertainties.

Inventory management

17. There were no changes to the inventory management process carried out by Luxembourg for the 2014 annual submission, as indicated by Luxembourg in its NIR. The description of the inventory management process, as contained in the report of the

individual review of the annual submission of Luxembourg submitted in 2013,[4] remains relevant.

18. The 2014 annual submission notes that Luxembourg is in the process of switching to a centralized database for the 2015 submission. Luxembourg provided an update during the review, in response to questions raised by the ERT, noting that the database software is already in place, and that Luxembourg is adapting the calculation sheets to the Extensible Markup Language (XML) format which can be exported and imported directly into the new web-based CRF Reporter to produce the official submissions for the European Union (EU) and the UNFCCC. This software update will include an automated key category analysis, which will extract the necessary data automatically from the database, minimizing the risk of errors when transferring the data from the CRF Reporter to the Excel calculation file.

5. Follow-up to previous reviews

19. Luxembourg includes in its annual inventory a development schedule for the consideration and implementation of recommendations made in previous review reports and recommendations made in other reviews (e.g. internal audits and reviews organized by the EU for EU member States). The QC procedures include checking that these recommendations have been considered and implemented. The results include improvements in the solvent and other product use sector to the data for the top-down approach (production statistics, import and export data) and for the bottom-up approach (revised AD provided by Luxembourg's hospital federation, now covering all hospitals). For the agriculture sector, the improvements include technical corrections.

20. The ERT noted that the previous review report included a recommendation that Luxembourg include more detailed information on its uncertainty analysis and key category analysis in the NIR. This recommendation was not implemented and the ERT therefore reiterates the recommendation made in the previous review report that Luxembourg include more detailed information on its uncertainty analysis and key category analysis in the NIR.

21. Recommendations made in previous review reports that have not yet been implemented, as well as issues the ERT identified during the 2014 annual review, are discussed in the relevant sectoral chapters of the report and in table 9 below.

B. Energy

1. Sector overview

22. The energy sector is the main sector in the GHG inventory of Luxembourg. In 2012, emissions from the energy sector amounted to 10,496.36 Gg CO_2 eq, or 88.7 per cent of total GHG emissions. Since 1990, emissions have increased by 0.6 per cent. The key drivers for this rise in emissions are population and economic growth. The population growth was mainly attributed to immigration, and it resulted in increasing demand for energy across many economic sectors (housing, offices, services and infrastructure). The strong growth in cross-border commuting and the location of Luxembourg at the heart of the main Western European transit routes for both goods and passengers led to an increase in transport fuel consumption (fuel prices in Luxembourg are usually lower than in neighbouring countries). The fastest growing subsectors in terms of GHG emissions were therefore energy industries and transportation, which grew by 2,812.5 per cent and 139.5 per cent, respectively, between 1990 and 2012. As a result, the shares of these categories in the energy sector emissions rose (from 0.3 per cent to 9.9 per cent for energy industries and

[4] FCCC/ARR/2013/LUX, paragraph 17.

from 25.1 per cent to 62.1 per cent for transportation). Increases in emissions were, however, offset by the decrease in emissions from manufacturing and construction, which decreased by 79.7 per cent compared with the 1990 level. Emissions from the categories other energy and fugitive emissions from solid fuels are reported as "NO" (not occurring).

23. Within the sector, 62.1 per cent of the emissions were from transport, followed by 15.5 per cent from other sectors, 12.2 per cent from manufacturing industries and construction and 9.9 per cent from energy industries. The remaining 0.4 per cent was fugitive emissions from fuels.

24. Luxembourg has made recalculations between the 2013 and 2014 annual submissions for this sector. The most significant recalculations were in manufacturing industries and construction, and transport.

25. The recalculations were made in response to recommendations in the 2013 annual review report and changes in AD due to corrections in the national energy balance (updated to make it consistent with the data submitted to the International Energy Agency (IEA)).The ERT welcomes Luxembourg's efforts to improve the accuracy of the estimations and encourages the Party to continue its effort to achieve consistency with data available from IEA and Eurostat. Compared with the 2013 annual submission, the recalculations increased emissions in the energy sector for 2011 by 14.18 Gg CO_2 eq (0.1 per cent), and increased total national emissions by 0.1 per cent. The recalculations were adequately explained in the NIR (section 10). However, the ERT reiterates the recommendation made in the 2012 review report that Luxembourg expand the recalculation sections within each category and subcategory to include values recalculated and the impact of the change, or include a cross-reference to section 10 from the energy sector of the NIR to improve transparency.

26. The ERT noted that Luxembourg has implemented most of the recommendations made in previous review reports regarding the correction of detected errors. However, the ERT noted that there are other recommendations pending: review the possible double counting of emissions from leisure boats reported under navigation; and collect country-specific data for estimating CH_4 emissions from natural gas distribution. In response to a question raised by the ERT during the review, the Party stated that it will investigate these issues and include specific checks for them in its QA/QC procedures. The ERT reiterates the pending recommendations.

2. Reference and sectoral approaches

27. Table 5 provides a review of the information reported under the reference approach and the sectoral approach, as well as comparisons with other sources of international data. Issues identified in table 5 are more fully elaborated in paragraphs 28–33 below.

Table 5
Review of reference and sectoral approaches

Issue	*Expert review team assessment*	*Paragraph cross-references*
Difference between the reference approach and the sectoral approach	Energy consumption: –0.31 PJ, –0.2% CO_2 emissions: –110.94 Gg CO_2, –1.1%	
Are differences between the reference approach and the sectoral approach adequately explained in the NIR and the CRF tables?	Yes	See paragraphs 28–30 below

Are differences with international statistics adequately explained?	Yes	
Is reporting of bunker fuels in accordance with the UNFCCC reporting guidelines?	Yes	See paragraphs 31–32 below
Is reporting of feedstocks and non-energy use of fuels in accordance with the UNFCCC reporting guidelines?	Yes	See paragraph 33 below

Abbreviations: CRF = common reporting format, NIR = national inventory report, UNFCCC reporting guidelines = "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories".

Comparison of the reference approach with the sectoral approach and international statistics

28. The ERT noted that the overall difference in the estimates of CO_2 emissions between the sectoral and reference approaches is less than 2.0 per cent for the entire time series, except for the year 2002 in which it was –2.2 per cent. However, the ERT noted that the difference in gaseous fuels between the sectoral and reference approaches is 3.9 per cent for 2011. In response to a question raised by the ERT during the review, Luxembourg clarified that there is a discrepancy between the plant-specific AD (used in the sectoral approach) and the AD from the energy balance (used in the reference approach). The plant-specific AD are higher than the data in the energy balance and the data reported to IEA. The Party explained that it is planning to provide a further quantitative assessment of the differences between the sectoral and reference approaches; further investigation is currently under way, and the Party indicated that there might be a fundamental inconsistency (e.g. that the energy balance uses a different net calorific value (NCV) for natural gas to that used in the inventory). The ERT recommends that the Party report and explain the differences between the reference and sectoral approaches, including the NCV used in the inventory and in the energy balance.

29. The ERT noted that Luxembourg has reported AD for lubricants as fuels as "NO" in the reference approach (CRF table 1.A(b)) but reports CO_2 emissions in the same table, and the ERT also noted that the NIR (section 3.2.3.1) mentions that there are emissions. In response to a question raised by the ERT during the review, the Party answered that a problem in the CRF Reporter software is responsible for this problem with reporting AD. The ERT recommends that the Party continue its efforts to fix this problem.

30. The ERT noted that, in the NIR (table 3.10, page 165), the Party mentions as a planned improvement that fuels used in marine activities will be subtracted from the reference approach where they are still included. The ERT reiterates the recommendation made in the previous review report that Luxembourg enter all fuels used in the country in the reference approach estimates, and improve its QC procedures.

International bunker fuels

31. As in previous review reports, the Party reported that there is only one airport for commercial aviation in Luxembourg and that all flights are international. The Party reports in its NIR 2014 (section 3.2.2.1, page 166) that all kerosene sales (for commercial flights) and 10 per cent of the aviation gasoline sales (for non-commercial flights) and their related emissions are allocated to international bunkers. As a planned improvement (NIR, page 169) the Party states its intention to analyse landing and take-off (LTO) data per aircraft type from Eurostat in order to optimize the split between "international bunkers – aviation" and "1A3a – civil aviation". The Party also stated that these data have only been available since 2004, and hence using these data for inventory purposes might be problematic because of time-series consistency issues. The ERT considers that the split between

national and international aviation emissions is not adequately explained and that the Party may be underestimating the emissions from international aviation (and therefore overestimating the emissions from civil aviation). The ERT reiterates the recommendation made in previous review reports that Luxembourg transparently describe the methodology used to split national and international (bunker) fuel consumption to ensure that civil aviation emissions are accurately estimated. The ERT notes that the IPCC good practice guidance (section 7.3.2.2) includes guidance on alternative recalculation methods that can also be used to obtain a consistent time series.

32. For marine bunkers, the NIR (section 3.2.8.5.2.2, page 220) mentions that 20 per cent of the gas oil used in shipping corresponds to international journeys reported under "international bunkers – marine". However, the ERT noted that international bunkers are reported as "NO" in CRF table 1.A(b) for gas/diesel oil. The ERT recommends that Luxembourg report fuel consumption in marine bunkers and associated emissions in the CRF tables.

Feedstocks and non-energy use of fuels

33. As in previous review reports, Luxembourg reported the fraction of carbon stored from lubricants as 50 per cent in CRF table 1.A(d) and indicated in the NIR (page 170) that the emissions from motor oil are reported under road transportation. In response to a question raised by the ERT during the review, Luxembourg stated that it will improve the transparency of section 3.2.3.1 of the NIR by adding a table listing AD, carbon stored and emissions, as well as listing in which CRF category they are reported. The ERT welcomes this planned improvement and recommends that Luxembourg implement it.

3. Key categories

Road transportation: liquid fuels – N_2O

34. As indicated in the previous review report, there are large differences in the N_2O implied emission factor (IEF) for gasoline for different years (ranging from 2.25 to 6.85 kg/TJ). The previous review report stated that Luxembourg planned to conduct a study on road transportation emissions. In the 2014 annual submission, Luxembourg reported N_2O IEFs for gasoline in NIR table 3–55 (page 217). However, there was no explanation for the fluctuations or reference to any study. In response to a question raised by the ERT during the review, the Party explained that the results of the above-mentioned study have not yet been integrated in the inventory, and that this integration is now foreseen for the 2015 submission, for which the entire road transportation and off-road mobile machinery categories will be revised. The ERT reiterates the recommendation made in the previous review report that Luxembourg incorporate relevant findings from the study on road transportation emissions into its inventory.

4. Non-key categories

Stationary combustion: liquid fuels – N_2O

35. The previous ERT noted that the N_2O IEF for liquid fuels for manufacturing industries and construction was the highest among reporting Parties for 2011. The current ERT noted that in the 2014 annual submission, the N_2O IEF continues to be the highest among reporting Parties for each year in the period 2000–2012 (the N_2O IEF for Luxembourg ranges from 9.71 kg/TJ to 24.24 kg/TJ, while for other reporting Parties it ranges from 12.84 kg/TJ to 19.74 kg/TJ). In addition, the N_2O IEFs for the subcategories

under manufacturing industries and construction are the highest among reporting Parties except for non-ferrous metals.[5] There are also significant inter-annual changes in the N_2O IEF for all of those subcategories.[6] As indicated in the previous review report, the ERT concluded that these subcategories mainly include emissions from off-road vehicles. In response to questions raised by the current ERT, Luxembourg explained that in its 2015 submission it plans to reallocate emissions from off-road mobile machinery in industry to the category mobile under other (fuel combustion) and to revise these emissions for off-road mobile machinery in order to better estimate CH_4 and N_2O emissions based on a higher-tier methodology. The Party also explained that this reallocation will induce a discrepancy with the IEA sectoral figures, which do not make the split between mobile and stationary combustion. The ERT welcomes the Party's planned effort to improve the transparency (through the reallocation) and accuracy of these emissions and reiterates the recommendation made in the previous review report that the Party report emissions from off-road vehicles under the category mobile under other (fuel combustion) and clearly explain any reallocation and recalculation in its NIR.

Oil and natural gas: natural gas – CH_4

36. As indicated in the previous review report, there is a significant inter-annual change in CH_4 emissions from natural gas distribution between 2010 (1.50 Gg CH_4) and 2011 (1.30 Gg CH_4) (Luxembourg has reported 1.33 Gg CH_4 for 2012). The 2011 value is 13.3 per cent lower than the 2010 value. The 2014 NIR states that in Luxembourg, a very small country, fluctuations in the time series are influenced by the maintenance stoppages of a single large industrial plant, the closure of an iron and steel production plant or colder winters (NIR, page 237). The ERT commends the Party for this explanation.

C. Industrial processes and solvent and other product use

1. Sector overview

37. In 2012, emissions from the industrial processes sector amounted to 610.74 Gg CO_2 eq, or 5.2 per cent of total GHG emissions, and emissions from the solvent and other product use sector amounted to 12.17 Gg CO_2 eq, or 0.1 per cent of total GHG emissions. Since the base year, emissions have decreased by 62.4 per cent in the industrial processes sector, and decreased by 49.1 per cent in the solvent and other product use sector. The key driver for the fall in emissions in the industrial processes sector is the change in the production process of steel from blast furnaces to electric arc furnaces between 1994 and 1998 (metal production constituted 60.7 per cent of emissions from this sector in 1990 but its contribution decreased to 16.4 per cent in 2012). Within the industrial processes sector, 71.2 per cent of the emissions were from mineral products, followed by 16.4 per cent from metal production and 12.4 per cent from consumption of halocarbons and SF_6. Emissions from the categories chemical industry, other production and production of halocarbons and SF_6 were reported as "NA" (not applicable) or "NO".

38. Luxembourg has made a recalculation between the 2013 and 2014 annual submissions for the industrial processes sector. The only recalculation was in consumption of halocarbons and SF_6 (the recalculation increased emissions for this category for 2011 by

[5] The ranges for the N_2O IEFs for Luxembourg are: iron and steel, 3.09–24.11 kg/TJ; chemicals, 2.25–20.17 kg/TJ; pulp, paper and print, 13.77–26.10 kg/TJ; food processing, beverages and tobacco, 9.17–23.51 kg/TJ; and other (manufacturing industries and construction), 11.17–24.58 kg/TJ.

[6] The inter-annual ranges for the N_2O IEFs are: iron and steel, –55.0 to 74.4 per cent; chemicals, –31.8 to 98.3 per cent; pulp, paper and print, –9.2 to 24.5 per cent; food processing, beverages and tobacco, –33.2 to 29.8 per cent; and other (non-specified), –16.5 to 31.9 per cent.

0.02 per cent). Compared with the 2013 annual submission, the recalculation increased emissions in the industrial processes sector by 0.02 Gg CO_2 eq (0.003 per cent), and increased total national emissions by 0.0001 per cent. However, the Party has not explained this recalculation in its NIR. The ERT recommends that the Party explain every recalculation in its NIR. Luxembourg has also recalculated the emissions from the solvent and other product use sector (the recalculation decreased the emissions for 2011 by 12.4 per cent) following an update of AD and EFs. The ERT noted that this recalculation is mentioned in pages 296–297 of the NIR but is not sufficiently explained, especially the change of EFs. The ERT also noted that the NIR (page 442) states incorrectly that no recalculations have been implemented in the solvent and other product use sector. The ERT recommends that the Party address this error and improve the QC procedures on the reporting of recalculations.

39. The ERT noted that Luxembourg has reported actual emissions for HFCs, PFCs and SF_6 from consumption of halocarbons and SF_6, but that potential emissions are reported as "NE" (not estimated), "NA" or "NO" in CRF tables 2(I) and 2(II). The ERT noted that this issue had been identified in previous review reports. The ERT reiterates the encouragement made in previous review reports that Luxembourg estimate and report potential emissions from consumption of halocarbons and SF_6.

40. The ERT noted a recommendation made in the 2012 review report that Luxembourg provide relevant explanations for the constant emissions for the period 1990–1995 for foam blowing (HFC emissions) and electrical equipment (SF_6 emissions). The emissions for the 1990–1995 period are still constant in the 2014 annual submission. In response to questions raised by the ERT during the review, Luxembourg explained that there are no AD for this period and that the emissions have been estimated by extrapolation, assuming the same emissions for the years 1990–1994 as for 1995. The Party also explained that after re-analysis of the available data, an extrapolation of the emission trend was considered the most realistic approach and relevant recalculation and background data and emissions will be reported in the next submission. The ERT recommends that Luxembourg revise its estimates of HFC emissions from foam blowing and SF_6 emissions from electrical equipment for 1990–1995 to ensure time-series consistency of these categories in accordance with the IPCC good practice guidance. The ERT notes that section 7.3.2.2 of the IPCC good practice guidance includes alternative recalculation methods.

2. Key categories

Cement production – CO_2

41. The CO_2 IEF for the year 2012 shows a 7.4 per cent decrease compared with that for 2011, while it is stable for the period 1990–2011. The NIR states that the reason for the decrease in the IEF (from 0.53 t CO_2/t in 2011 to 0.49 t CO_2/t in 2012) is a change in the raw material consumption, so that it can no longer be assumed that all the calcium oxide (CaO) and magnesium oxide (MgO) in the clinker are from carbonate sources. The ERT commends Luxembourg for the information given in the NIR.

Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6

42. The ERT noted that Luxembourg has reported HFC and PFC emissions from refrigeration and air-conditioning equipment and SF_6 emissions from noise reduction windows (reported under other (consumption of halocarbons and SF_6)) in CRF tables 2(I) and 2(II), but the Party has not reported AD, IEF or emissions in CRF table 2(II).F. The ERT reiterates the recommendation made in previous review reports that Luxembourg report AD, IEF and emissions from refrigeration and air-conditioning equipment and noise reduction windows in CRF table 2(II).F to improve the consistency of its reporting.

43. In response to recommendations made in the previous review report, Luxembourg has included estimates of SF_6 emissions from electrical equipment using a country-specific method based on the installed capacity with the total nameplate capacity from the largest operator (80 per cent coverage). The yearly emissions are assumed to vary between 0.1 per cent and 0.9 per cent, depending on the type of switchgear. The EFs are those used in the inventory of Germany. In response to a question raised by the ERT during the review, the Party indicated that it used a tier 2a method from the IPCC good practice guidance for the calculation of SF_6 emissions from electrical equipment. However, information in the NIR is not sufficient to evaluate and verify the estimations. The ERT reiterates the recommendation in the previous report that Luxembourg provide a more detailed explanation in the NIR of the methodologies and AD used to estimate SF_6 emissions from electrical equipment in order to increase the transparency of its reporting.

44. The ERT notes that Luxembourg reports estimates for actual PFC emissions from refrigeration and air-conditioning equipment in CRF table 2(I), but the Party continues to use the notation key "NO" to report potential emissions. The ERT reiterates the recommendation made in the previous review report that the Party replace the notation key "NO" with either a value or the notation key "NE".

45. The ERT noted that Luxembourg continues to estimate HFC and PFC emissions from transport refrigeration, foam blowing and aerosol/metered dose inhalers using per capita emissions from Belgium and Germany (NIR, page 265). In response to questions raised by the ERT during the review, Luxembourg explained that it will be able to estimate the emissions from transport refrigeration using country-specific data in the 2015 submission. Regarding foam blowing and aerosol/metered dose inhalers, the Party explained that Luxembourg relies entirely on imports and, owing to the lack of import data in the national statistics, major importers were (and are) contacted in order to obtain information on sales data and product specifications. The ERT appreciates Luxembourg's efforts and encourages the Party to estimate these emissions using country-specific AD.

3. Non–key categories

Solvent and other product use – N_2O

46. N_2O emissions from anaesthesia have been estimated for the period 1990–2002 by combining per capita N_2O emissions from Germany with the population in Luxembourg because there are no country-specific data available. For the period 2003–2012, emissions have been estimated using country-specific data collected from hospitals in Luxembourg. In response to a question raised by the ERT during review, the Party explained that it used N_2O emissions per capita from Germany because of the similar national circumstances in terms of the ratio of commuters and the rate of hospitalization abroad as well as a comparable health system between the two countries. The ERT noted that the N_2O emissions per capita in Germany in 2002 and in Luxembourg in 2003 are similar (39.42 g N_2O per capita and 38.11 g N_2O per capita, respectively), but this does not constitute a confirmation that the time series is consistent. The ERT reiterates the recommendation made in previous review reports that the Party demonstrate the consistency of the time series or collect country-specific data for the entire time series.

D. Agriculture

1. Sector overview

47. In 2012, emissions from the agriculture sector amounted to 668.68 Gg CO_2 eq, or 5.6 per cent of total GHG emissions. Since 1990, emissions have decreased by 10.2 per cent. The key drivers for the fall in emissions are the decreasing livestock numbers, in

particular mature dairy cattle, and the decrease in the use of synthetic fertilizers applied to soils. Within the sector, 45.3 per cent of the emissions were from agricultural soils, followed by 35.8 from enteric fermentation and 18.9 per cent from manure management. Luxembourg reported emissions from rice cultivation, prescribed burning of savannas, field burning of agricultural residues and other (agriculture) as "NA" or "NO".

48. Luxembourg has made two recalculations between the 2013 and 2014 annual submissions for this sector. The two recalculations were in manure management (emissions increased by 5.4 per cent and 0.9 per cent for 2011 and 1990, respectively) and agricultural soils (emissions increased by 4.7 per cent and 0.1 per cent for 2011 and 1990, respectively). The recalculations were made in manure management to reflect revised manure allocations in animal waste management systems (AWMS) from 2005 to 2011 and revised nitrogen excretion (Nex) rates for horses in 2010 and 2011. Recalculations were also made in agricultural soils to reflect updates in provisional fertilizer applied to soils and crop data (e.g. peas and other tubers and roots) as well as following the revisions in manure management. In addition, N_2O emissions from manure management and from agricultural soils and CH_4 emissions from manure management (from other AWMS) were resubmitted in response to the list of potential problems and further questions raised by the ERT during the review (see paras. 49, 51, 52 and 54 below). Compared with the 2013 annual submission, the recalculations increased emissions in the agriculture sector for 2011 by 20.50 Gg CO_2 eq (3.1 per cent) and increased total national emissions by 0.2 per cent. The recalculations were well described in sections 6.3.5 and 6.5.4 and tables 6-37 and 6-36 of the NIR and in CRF table 8(b).

2. Key categories

Manure management – CH_4 and N_2O

49. Luxembourg allocated manure from several livestock categories to the subcategory "other (animal waste management systems)" in 2012 (mature dairy cattle (6.99 per cent), mature non-dairy cattle (1.65 per cent), young cattle (3.62 per cent), swine (5.00 per cent) and poultry (25.00 per cent)) as indicated in CRF table 4.B(a). Other AWMS in Luxembourg are anaerobic digesters at farms or municipal installations. In its submission of 15 April 2014, Luxembourg used a methane conversion factor (MCF) of 0.0 per cent (zero) for manure allocated to this manure management system, stating in the NIR (page 323) that "it is a conservative estimate reducing/limiting our emissions for the base year". The ERT considers that a zero MCF is also potentially underestimating CH_4 emissions from the subcategory "other (animal waste management systems)" for all other years in the time series 1990–2012. In addition, the ERT notes that the same issue was raised in the previous review report.[7] In response to a question raised by the ERT during the review, Luxembourg replied that the MCF in the 2014 submission is the same as in the previous submission (zero). This issue was included in the list of potential problems and further questions raised by the ERT. In its response to this list, Luxembourg submitted revised estimates for CH_4 emissions from manure management for the entire time series 1990–2012 on 17 November 2014, using an MCF of 13.0 per cent for manure managed in anaerobic digesters (i.e. for other AWMS) based on information provided by Mr. P. Delfosse and Mr. Hoffmann in 2014.[8] The ERT considers that the revised estimates resolved the potential underestimation. Compared with the estimates submitted in April 2014, the revised estimates submitted on 17 November 2014 increased CH_4 emissions from manure management by 4.9 per cent for

[7] FCCC/ARR/2013/LUX, paragraph 48.

[8] Mr. Philippe Delfosse (Project Leader in Bioenergy, Centre de Recherche Public – Gabriel Lippmann) and Mr. Hoffmann, personal communication, November 2014.

2012, or 4.40 Gg CO_2 eq. The ERT recommends that the Party describe these changes in its NIR.

50. Luxembourg estimates CH_4 emissions from manure management from swine using a tier 1 method and IPCC default EF (using equation 4.17 of the IPCC good practice guidance and default parameters from the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines) for gross energy intake (GE), digestible energy (DE), ash content of manure (ASH), volatile solids (VS) and methane producing potential (B_o)). The ERT notes that swine is a significant species for the Party, accounting for 41.2 per cent of CH_4 emissions from manure management in 2012. The ERT also notes the recommendations made in previous review reports that Luxembourg develop and apply higher-tier methods for the estimation of CH_4 emissions from manure management for swine.[9] In response to a question raised by the ERT during the review, Luxembourg stated that it was not possible to implement a tier 2 method for this submission but that it will be implemented in the 2015 submission. The ERT reiterates the recommendations made in previous review reports that Luxembourg implement a higher-tier method for manure management from swine.

51. Luxembourg estimates N_2O emissions from manure management for all livestock categories using a tier 1 method. In the estimations submitted in April 2014, Luxembourg used three different Nex rates for mature dairy cattle. The Nex rates are estimated based on the milk yield. The three different Nex rates are: 85.00 kg N/head/year for a milk yield lower than 5,500 kg/head/year; 93.50 kg N/head/year for a milk yield between 5,500 kg/head/year and 6,500 kg/head/year; and 102.00 kg N/head/year for a milk yield higher than 6,500 kg/head/year. The ERT notes that the milk production for 2012 reported in CRF table 4.A is 7,260 kg/head/year (reported as 19.88 kg/day), 11.7 per cent higher than 6,500 kg/head/year.

52. The ERT considers that the Nex rate used by Luxembourg for mature dairy cattle with a milk yield higher than 6,500 kg/head/year (102.00 kg N/head/year) is too low, given the current milk yield of 7,260 kg/head/year. The ERT notes that the same issue was raised in the previous review report.[10] In response to a question raised by the ERT during the review, Luxembourg explained that the Nex rate used in the 2014 submission is the same as in the previous submission. The ERT considers that by using the Nex value of 102.00 kg N/head/year, Luxembourg is potentially underestimating the N_2O emissions from manure management and agricultural soils (for subcategories direct soil emissions, pasture, range and paddock manure, and indirect emissions; see para. 54 below). This issue was included in the list of potential problems and further questions raised by the ERT. In its response to this list, Luxembourg submitted revised estimates on 17 November 2014 for the entire time series using Nex rates derived from an equation from a study by Steinwidder and Guggenberger (2003) based on milk yield.[11] For example, for the milk yield in 2012, the corresponding Nex rate used in the revised estimates is 107.89 kg N/head/year. The ERT considers that the revised estimates resolved the issue. The revised estimates increased N_2O emissions from manure management by 0.6 per cent in 2012 or 0.19 Gg CO_2 eq. The ERT recommends that the Party describe these changes in its NIR.

Agricultural soils – N_2O

53. Luxembourg estimates N_2O emissions from agricultural soils using tier 1 methods from the IPCC good practice guidance. This category has been identified as a key category.

[9] FCCC/ARR/2013/LUX, paragraph 50.
[10] FCCC/ARR/2013/LUX, paragraph 49.
[11] Nex (kg N/head/year) = 0.009 × kg milk yield (kg/year) + 42.5.

The ERT noted that the decision tree in the IPCC good practice guidance (page 4.55) indicates that a Party can estimate emissions using default volatilization fractions, $Frac_{GASF}$ and $Frac_{GASM}$, even for a key category (where $Frac_{GASF}$ is the fraction of synthetic fertilizer nitrogen (N) applied to soils that volatilizes as ammonia (NH_3) and nitrogen oxides (NO_X) and $Frac_{GASM}$ is the fraction of livestock N excretion that volatilizes as NH_3 and NO_X). The IPCC good practice guidance (page 4.61) also encourages Parties to use appropriately documented loss rates for synthetic fertilizer and animal manures applied to soils. The ERT encourages Luxembourg to develop country-specific parameters volatilization fractions from fertilizers and animal manures ($Frac_{GASF}$ and $Frac_{GASM}$) for this key category.

54. The ERT noted that N_2O emissions from agricultural soils were included in the list of potential problems and further questions raised by the ERT and that Luxembourg submitted revised estimates on 17 November 2014 that solved the potential underestimation (see paras. 51 and 52 above). Luxembourg, in its revised estimates, also revised: the amount of synthetic fertilizer applied to soils for the years 2008–2012 to reflect final data instead of previously submitted provisional data; AD for peas, carrots and leaks for 2012; and the amount of sewage sludge applied to soils for 2012. The overall effect of these revisions on total direct and indirect N_2O from agricultural soils was to reduce emissions of N_2O in 2012 by 1.8 per cent or 5.70 Gg CO_2 eq. However, the total cumulative emissions of N_2O from 2008 to 2012 increased by 7.64 Gg CO_2 eq (or 0.5 per cent) as a result of this resubmission. The ERT recommends that the Party transparently describe the methodology used to estimate these emissions in its NIR.

E. Land use, land-use change and forestry

1. Sector overview

55. In 2012, net removals from the LULUCF sector amounted to 438.03 Gg CO_2 eq. Since 1990, the LULUCF sector has changed from a net source (emissions of 331.61 Gg CO_2 eq) to a net sink. The key driver is the recovery of forest land remaining forest land following major disturbances in 1990. Within the sector, 514.80 Gg CO_2 eq of net removals were from forest land, followed by 46.14 Gg CO_2 eq from grassland. Net emissions were reported from settlements (78.80 Gg CO_2 eq), cropland (37.12 Gg CO_2 eq), wetlands (6.62 Gg CO_2 eq) and other land (0.37 Gg CO_2 eq).

56. Luxembourg has made recalculations between the 2013 and 2014 annual submissions for all categories in this sector. The most significant recalculations were in the following categories:

(a) Forest land: net removals for 2011 increased by 9.4 per cent and net emissions for 1990 decreased by 35.8 per cent;

(b) Cropland: net emissions for 2011 and 1990 increased by 42.4 per cent and 36.1 per cent, respectively;

(c) Grassland: for 2011, net emissions (31.19 Gg CO_2 eq) became net removals (49.00 Gg CO_2 eq) and net emissions for 1990 increased by 9.6 per cent;

(d) Settlements: net emissions for 2011 decreased by 23.4 per cent and for 1990 increased by 7.9 per cent.

57. The recalculations were made following changes in AD, namely land-use change areas, arising from the availability of new data for the period 2008–2012. Compared with the 2013 annual submission, the recalculations increased net removals in the LULUCF sector for 2011 by 140.77 Gg CO_2 eq (47.8 per cent). The recalculations were adequately explained. The ERT commends Luxembourg for the clarity of the description of the recalculations.

58. References for EFs and AD were not provided in a systematic manner (e.g. the meaning of "IFL1" in the NIR, page 367; the soil carbon content of various land uses; the country-specific value for carbon stock of forest land biomass before conversion; the annual volume increment of species other than spruce, Douglas fir, beech and oak). In response to questions raised by the ERT during the review, Luxembourg was able to clarify most of the references and, where necessary, provide copies of these references to the ERT. In some cases, Luxembourg identified errors and explained that the EFs were based on expert judgement rather than the originally quoted reference (e.g. annual volume increment for spruce and Douglas fir in the NIR, page 370). The ERT reiterates the recommendation made in the previous review report that Luxembourg improve the transparency of its reporting by providing references for the LULUCF and KP-LULUCF sectors in a systematic and comprehensive adequate and exhaustive manner in its NIR.

59. Luxembourg reported that checking whether a complete set of references is provided for EFs and AD is part of its QC procedures. However, in view of the multiple missing references (see para. 58 above), the ERT concluded that the relevant QC procedures had not been thoroughly conducted. In addition, inconsistencies were detected between the NIR and the CRF tables (see para. 68 below). The ERT reiterates the recommendation made in the previous review report that Luxembourg improve its QC procedures, in particular regarding references for EFs and AD, and regarding consistency between the NIR and the CRF tables.

60. The results of the uncertainty analysis for the LULUCF sector were only reported for forest land (NIR, table 1-10). This partial reporting is not in line with the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF) (see para. 16 above). In response to a question raised by the ERT during the review on the source of information for the reported values, Luxembourg provided a study conducted in 2011 which calculated uncertainties of 20 per cent for the annual volume increment and between 12.5 per cent and 25 per cent for harvested volume. However, Luxembourg was not able to clarify how this assessment resulted in the reported values of 57 per cent for AD (area of land converted to forest land) and 10 per cent for EF (carbon stock change per hectare). Luxembourg explained that the publication of its second national forest inventory (NFI) (published in March 2014) would enable it to revise these estimates for the 2015 annual submission. The ERT recommends that Luxembourg report its uncertainty analysis for LULUCF in accordance with the IPCC good practice guidance for LULUCF and transparently describe the method used to estimate the uncertainty.

2. Key categories

Forest land remaining forest land – CO_2

61. Luxembourg estimates carbon stock changes in living biomass using the "default method" as defined by the IPCC good practice guidance for LULUCF (page 3.24). Harvest statistics strongly influence this type of estimate, but the ERT notes that these are not reproduced in the NIR. In response to a question raised by the ERT during the review, Luxembourg provided harvest statistics for the period 1990–2012 sourced from national statistics (STATEC). The ERT noted that despite a 45 per cent increase in harvest between 2009 and 2010 (STATEC), the carbon stock in living biomass from forest land remaining forest land increases at relatively stable rate: annual values ranged within 10 per cent of the 2006–2012 average of 107.47 Gg carbon (C) per year. The ERT would have expected the large 2010 harvest increase to be reflected in a large drop in carbon stock change for living biomass. In addition, the ERT noted discrepancies of up to 87 per cent (for 2010) between the harvest data used in the inventory (STATEC) and the data provided by Luxembourg to the Food and Agriculture Organization of the United Nations database (FAOSTAT). The ERT recommends that Luxembourg:

(a) Reproduce the entire time series of harvest statistics;

(b) Provide an explanation for the inconsistency between harvesting trends and carbon stock changes in living biomass;

(c) Investigate the discrepancy between STATEC and FAOSTAT data on harvest.

62. Forest land remaining forest land is the category with the largest contribution to removals in the LULUCF sector. During the previous review, Luxembourg informed the ERT that the results of the second NFI would be available in 2013 and that there were plans to recalculate the emission/removal estimates based on those results. In response to the request for a progress update raised by the ERT during the current review, Luxembourg informed the ERT that some delays had occurred, but that the results of the second NFI had been officially validated in March 2014. Luxembourg provided these results to the ERT and confirmed that they would be used in the 2015 submission. The ERT therefore reiterates the recommendation made in the previous review report that Luxembourg use the results from the second NFI to recalculate the emission/removal estimates from forest land remaining forest land and all categories involving forest land.

63. As noted in previous review reports, the area of forest land in 2011 reported in CRF table 5.A is 95.8 kha compared with 87 kha reported to FAOSTAT. In response to a question raised by the ERT during the review, Luxembourg indicated that this difference needs to be reviewed with the ministry responsible for communicating data to FAOSTAT. The ERT noted that this response from Luxembourg is the same as responses to similar questions raised during previous reviews. The ERT recognizes that there may be reasons for the different areas of forest reported to the different organizations (e.g. because of different definitions), but reiterates the encouragement that the Party transparently discuss in the NIR why such differences may arise.

Land converted to forest land – CO_2

64. Luxembourg does not explain the method used to estimate the increment of species other than beech, oak, spruce and Douglas fir. In response to a question raised by the ERT during the review, Luxembourg was able to provide the references for these increment values and to clarify how harvest was accounted for. In addition, Luxembourg explained that the publication of its second NFI would enable it to revise these estimates in its 2015 annual submission, using more recent and relevant values for both increment and harvests. The ERT welcomes these planned improvements and recommends that Luxembourg transparently describe them.

65. Luxembourg does not explicitly report its method for calculating carbon stock changes for conversions to forest land from wetlands, settlements and other land. In response to a question raised by the ERT during the review, Luxembourg clarified that the method was the same as that for conversions from grassland, except that the carbon stocks before land-use change were those reported in the relevant section of the NIR (wetland, settlements and other land). The ERT welcomes this clarification and recommends that Luxembourg include this information in its NIR.

Land converted to grassland – CO_2

66. The area converted annually from forest land to grassland strongly decreased from 212 ha/year over the period 2000–2007 to 14 ha/year over the period 2008–2012. The methodology used to estimate these areas is in line with the IPCC good practice guidance for LULUCF. In response to a question raised by the ERT during the review on the drivers for this important decrease, Luxembourg explained that the accuracy of the 2000–2007 values was being assessed in view of the new AD for 2008–2012, recalculated based on

remote sensing imagery for 2012. The ERT commends Luxembourg for conducting this assessment. The ERT recommends that in doing this assessment, Luxembourg pay particular attention to areas that may have undergone a back-and-forth classification from and to forest land, because these may have remained forest land all along. The ERT recommends that Luxembourg report on the results of this investigation.

67. Luxembourg reports in its NIR that "the areas with more than one land use change within 20 years are taken into account as LUC [land-use change] areas, whereas, according to the IPCC good practice guidance for LULUCF, they should stay in their main category" (page 363). Accordingly, Luxembourg corrects the raw data from its land identification method and only reports a fraction (269 ha/year in 2012) of cropland converted to grassland in the category land converted to grassland. The rest of the area identified as cropland converted to grassland is reported in the grassland remaining grassland category. In response to a question raised by the ERT during the review, Luxembourg was not able to clarify which part of the IPCC good practice guidance for LULUCF allowed for reporting cropland converted to grassland in the grassland remaining grassland category. The ERT recommends that Luxembourg report all areas of cropland converted to grassland in the category land converted to grassland.

3. Non-key categories

Cropland remaining cropland – CO_2

68. The ERT noted that there were inconsistencies in the reporting of emissions and removals between the NIR and CRF table 5.B. For example, for 2012, Luxembourg reported emissions of 3.92 Gg CO_2 eq for cropland remaining cropland in NIR table 7-13 (page 375) but emissions of 5.28 Gg CO_2 eq in CRF table 5.B in its submission on 15 April 2014. In response to a question raised by the ERT during the review, Luxembourg acknowledged the issue and identified the NIR values as the correct ones. However, the ERT notes that the revised estimates submitted by the Party on 17 November 2014 were still inconsistent between the NIR and the CRF table values for the entire time series 1990–2012 (e.g. for 2012, 3.24 Gg CO_2 eq is reported in CRF table 5). The initial inconsistency had been corrected but another, different, inconsistency had arisen after the revision of estimates for soil carbon changes. The ERT recommends that the Party correct its NIR to ensure consistency between the NIR and the CRF tables.

69. Luxembourg has reported carbon stock changes in living biomass from perennial crops to annual crops using the tier 1 method (i.e. using a default EF of 63 Mg C/ha/year from table 3.3.2 in the IPCC good practice guidance for LULUCF). This estimate is in line with the IPCC good practice guidance for LULUCF. However, in response to a question raised by the ERT during the review, Luxembourg informed the ERT that vineyards constitute the vast majority of perennial crops in Luxembourg, accounting for 1,294 ha of 1,438 ha. The ERT notes that the default EF in the IPCC good practice guidance for LULUCF is representative of tree crops such as orchards, and considering that the living biomass of vineyards is probably smaller than that of orchards, the ERT encourages Luxembourg to develop a country-specific EF, for example by considering the EF used by neighbouring countries with vineyards covering large areas of land.

Land converted to wetlands – CO_2 and CH_4

70. Luxembourg has reported soil carbon stock losses of 3.77 Mg C/ha/year from cropland converted to wetlands and soil carbon stock losses of 5.08 Mg C/ha/year from grassland converted to wetlands in 2012 (CRF table 5.D). The Party has assumed that these losses are emitted as CO_2. The IPCC good practice guidance for LULUCF does not provide a method to estimate these emissions. However, appendix 3a.3 of the IPCC good practice

guidance for LULUCF provides a method whereby part of the soil carbon stock losses is emitted as CH_4 as a result of anaerobic respiration. In response to a question raised by the ERT during the review, Luxembourg acknowledged that appendix 3a.3 may be considered but pointed out that this category was a minor source of emissions and therefore not a priority for improvement. The ERT agrees with Luxembourg that improving this estimate may not be a priority. Nevertheless, the ERT encourages Luxembourg to list this issue in its improvement plan.

Direct N_2O emissions from nitrogen fertilization of forest land and other – N_2O

71. The previous review report recommended that Luxembourg provide verification that forest fertilization does not occur. In its NIR, Luxembourg explains that forest fertilization is not practised in Luxembourg. The ERT noted that the entire amount of fertilizer sold in Luxembourg is reported as applied on cropland (NIR, page 340) and the associated N_2O emissions reported in the agriculture sector, and considers that this is satisfactory evidence that forest fertilization is not occurring. The ERT recommends that Luxembourg explicitly explain this in its NIR.

Biomass burning – CH_4 and N_2O

72. The previous review report recommended that Luxembourg provide verification that the practice of biomass burning is not occurring on cropland and grassland. In its NIR, Luxembourg states that biomass burning is not practised in Luxembourg. The ERT is satisfied with the information reported by the Party. The ERT recommends that Luxembourg explicitly provide this explanation in its NIR.

F. Waste

1. Sector overview

73. In 2012, emissions from the waste sector amounted to 50.24 Gg CO_2 eq, or 0.4 per cent of total GHG emissions. Since 1990, emissions have decreased by 39.1 per cent. The key drivers for the fall in emissions are reduced emissions from solid waste disposal sites (SWDS) and from the treatment of wastewater. The declining trend in emissions from SWDS can be attributed to increased recycling, mechanical–biological (MB) pre-treatment of the collected waste before disposal and increased landfill gas recovery. Increased and enhanced treatment of wastewater has decreased emissions from this category. Within the sector, 51.7 per cent of the emissions were from solid waste disposal on land, followed by 27.6 per cent from other (waste) and 20.6 per cent from wastewater handling. Emissions from waste incineration were reported as "IE" (included elsewhere).

74. Luxembourg has made recalculations between the 2013 and 2014 annual submissions for this sector. The most significant recalculation was in the category other (waste), where GHG emissions from compost production for 2011 decreased by 16.8 per cent (emissions are reported as "NO" for 1990). This recalculation was made to replace provisional AD with final AD. Compared with the 2013 annual submission, the recalculations decreased emissions in the waste sector for 2011 by 2.55 Gg CO_2 eq (4.4 per cent) and decreased total national emissions by 0.02 per cent. The recalculations were adequately explained.

2. Key categories

Solid waste disposal on land – CH_4

75. Luxembourg estimates the CH_4 emissions from solid waste disposal on land based on the tier 2 methodology in the 2006 IPCC Guidelines (volume 5, section 3.2.1). Part of the solid waste is pre-treated mechanically and aerobically before disposal. The MB pre-treatment reduces the volume of and degradable organic matter in the waste. Luxembourg assumes that the methane correction factor value for pre-treated waste is reduced from 1 to 0.1 based on the 2006 IPCC Guidelines, which state that MB-treated waste will produce up to 95 per cent less CH_4 than untreated waste when disposed in SWDS (2006 IPCC Guidelines, volume 5, section 4.1, page 4.4). The ERT notes that the 2006 IPCC Guidelines also state that practical reductions have been smaller and depend on the type and duration of MB treatments. The ERT recommends that Luxembourg assess whether the assumption of the 90 per cent reduction is valid for its national circumstances and provide the results of this assessment. The ERT also notes that the 2006 IPCC Guidelines give a method to estimate the fugitive CH_4 and N_2O emissions from the MB treatment; Luxembourg has not included these emissions in its 2013 inventory submission.

3. Non–key categories

Wastewater handling – N_2O

76. Luxembourg estimates N_2O emissions from wastewater treatment using a country-specific methodology based on the methodology in the 2006 IPCC Guidelines (see para. 77 below). The N_2O emissions are estimated separately for uncollected wastewater and for wastewater treatment plants with and without significant denitrification. The N_2O emissions from human sewage as well as those from commercial and industrial wastewater are included in these emissions.

77. The N_2O emissions from uncollected wastewater are estimated using the default method for N_2O emissions from wastewater effluent in the 2006 IPCC Guidelines (volume 5, section 6.3.1, equation 6.8, page 6.25). The country-specific methodology to estimate N_2O emissions from wastewater treatment plants is a combination of the method given in the 2006 IPCC Guidelines (volume 4, section 6.3.1, box 6.1, page 6.26) and a country-specific method. The IPCC methodology applies to N_2O emissions from advanced centralized wastewater treatment plants with controlled denitrification and nitrification. The IPCC default factor for these plants is very low (3.2 g N_2O/person/year). Luxembourg applies this method for plants with biological wastewater treatment with significant denitrification rates (approximately 75 per cent) of the incoming N load. The country-specific method is based on the denitrification rate at other types of wastewater treatment plants, for which an average denitrification rate of 35 per cent is assumed. For these plants, 1 per cent of the N denitrified is assumed to be emitted as N_2O. The ERT considers that the use of a country-specific EF for plants without significant denitrification, which is higher than the EF used for plants with significant denitrification (for which the 2006 IPCC default EF, much lower, is used), is inconsistent with the fact that increased denitrification usually leads to increased N_2O emissions. The ERT recommends that Luxembourg review the N_2O EF for plants with significant denitrification and use a consistent methodology to estimate these emissions, for example by also using the country-specific method for wastewater treatment plants with significant denitrification.

78. Luxembourg has applied a method from the 2006 IPCC Guidelines for N_2O emissions from wastewater effluent (volume 5, section 6.3.1.1) only to the wastewater which is not collected. For collected wastewater, N_2O emissions from treatment at the plants have been estimated, but not N_2O emissions from the effluent discharged from the

plants. The ERT recommends that Luxembourg review the estimations from all discharges of wastewater, including those from wastewater plants, to confirm that all N_2O emissions are estimated. The N removal at these plants should be considered in the estimates.

79. The ERT also noted that Luxembourg includes N_2O emissions from sludge spreading under the agriculture sector, but that it has not subtracted the corresponding amount of N from the wastewater emission calculations. The ERT recommends that Luxembourg take into account the N removed in the sludge spread on agricultural fields when estimating the N_2O emission from wastewater in order to avoid double counting. The ERT also recommends that Luxembourg revise its method to estimate the N_2O emissions from wastewater handling, taking into account all the above-mentioned inconsistencies and omissions (see paras. 77 and 78 above).

Other (waste) – CH_4 and N_2O

80. Luxembourg reports CH_4 and N_2O emissions from compost production under this category using the tier 1 (default) methodology and EFs from the 2006 IPCC Guidelines (volume 5, section 4.1). The ERT commends the Party for estimating these emissions for which the Revised 1996 IPCC Guidelines and the IPCC good practice guidance do not have a methodology. Luxembourg also reports that MB treatment takes place before disposal of solid waste (see para. 75 above) but has not clarified further the MB treatment in the NIR. As both composting and anaerobic digestion may be part of MB pre-treatment of waste, the ERT encourages Luxembourg to provide further information on the MB treatment in the NIR, and complement its reporting by covering all emissions from biological treatment, as appropriate.

G. Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

1. Information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

Overview

81. Table 6 provides an overview of the information reported and parameters selected by Luxembourg under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.

Table 6
Supplementary information reported under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

Issue	*Expert review team assessment, if applicable*	*Findings and recommendations*
Assessment of Luxembourg's reporting in accordance with the requirements in paragraphs 5–9 of the annex to decision 15/CMP.1	Sufficient	
Activities elected under Article 3, paragraph 4, of the Kyoto Protocol	Activities elected: none	
Period of accounting	Commitment period	
Luxembourg's ability to identify areas of land and areas of land-use change in accordance with paragraph 20 of the annex to decision 16/CMP.1	Sufficient	

82. Section G.1 includes the ERT's assessment of the 2014 annual submission against the Article 8 review guidelines and decisions 15/CMP.1 and 16/CMP.1. In accordance with decision 6/CMP.9, Parties will begin reporting of KP-LULUCF activities in the submissions due by 15 April 2015 using revised CRF tables, as contained in the annex to decision 6/CMP.9. Owing to this change in the CRF tables for KP-LULUCF activities and the change from the first commitment period to the second commitment period, paragraphs 83–91 below contain the ERT's assessment of Luxembourg's adherence to the current guidelines for reporting and do not provide specific recommendations for reporting these activities for the 2015 annual submission.

83. Luxembourg has reported in its NIR (page 402) that tree species are identified from satellite images. In response to a question raised by the ERT during the review, Luxembourg clarified that only a distinction between coniferous and broadleaf species could be obtained from satellite images, thanks to the lower reflection of coniferous trees in visible and infrared wavelengths. Further disaggregation into species is obtained from NFI data averages for the 0–20 years age class. The ERT commends Luxembourg for its rigorous use of reporting method 2 for lands subject to activities under Article 3, paragraph 3, of the Kyoto Protocol and welcomes the clarification on species mix estimation. The ERT recommends that Luxembourg improve the transparency of its reporting by including this explanation in its NIR.

84. Luxembourg reports in its NIR (page 53) that the categories land converted to forest land and land converted to settlements are identified as key categories. According to the IPCC good practice guidance for LULUCF, this means that afforestation and reforestation, and deforestation activities under Article 3, paragraph 3, of the Kyoto Protocol, are also key categories. In response to a question raised by the ERT during the review, Luxembourg acknowledged this conclusion. The ERT recommends that Luxembourg classify afforestation and reforestation, and deforestation as key categories if the aforementioned Convention categories are identified as key categories.

85. For both afforestation and reforestation, and deforestation activities, Luxembourg reports carbon stock changes in below-ground biomass and litter as "IE" (they are reported under above-ground biomass and soil carbon, respectively). In response to a question raised by the ERT during the review, Luxembourg explained that separate reporting of these pools only became possible in March 2014 with the publication of the second NFI. Luxembourg further clarified that it would report these pools separately in its 2015 annual submission. The ERT reiterates the recommendation made in the previous review report that Luxembourg separately report carbon stock changes in below-ground biomass and litter for the KP-LULUCF categories.

Activities under Article 3, paragraph 3, of the Kyoto Protocol

Afforestation and reforestation – CO_2

86. The ERT notes that Luxembourg reported the carbon stock changes in the below-ground living biomass pool as included elsewhere ("IE") in the CRF tables and reported them together with the above-ground pool (see para. 85 above). The Party explains in its NIR that the carbon stock changes in below-ground biomass are included in the above-ground biomass. However, the ERT noted that decision 16/CMP.1, annex, paragraph 21, specifies that carbon stock changes in five pools must be accounted for (or transparent and verifiable information that the pool is not a source must be provided), namely: above-ground biomass, below-ground biomass, dead wood, litter and soil organic carbon. The ERT also noted that there is information already available to report the carbon stock changes for below-ground biomass separately (NIR, page 371). In response to a question raised by the ERT during the review, the Party explained that this issue had not been assigned a high priority within the improvement plan. While acknowledging that reporting

the pools separately is not strictly speaking mandatory, the ERT reiterates the recommendation made in the previous review report that Luxembourg improve the transparency of its reporting under the Kyoto Protocol and separately report the carbon stock changes for the living biomass pools (above-ground and below-ground) using the information already available within its national inventory system.

87. The ERT noted that in order to ensure consistency with the revisions made for deforestation in response to the list of potential problems and further questions raised by the ERT during the review (see paras. 88–91 below), Luxembourg revised the estimates for afforestation and reforestation.

Deforestation – CO_2

88. In order to estimate changes in mineral soil organic carbon stock (SOC) in deforestation due to the conversion of forest to grassland, Luxembourg uses a country-specific IEF of –0.35 t C/ha/year (NIR, page 387). This IEF derives from applying equation 3.4.8 of the IPCC good practice guidance for LULUCF ($(SOC_{forest\ land} - SOC_{grassland})/20$), with:

(a) $SOC_{forest\ land} = SOC_{ref} \times F_{forest\ land} \times F_{MG} \times F_I = 85$ t C/ha (NIR, page 373), where F_{MG} is the stock change factor for the management regime, F_I is the stock change factor for input of organic matter and SOC_{ref} is the reference soil organic carbon stock;

(b) $SOC_{grassland} = SOC_{ref} \times F_{grassland} \times F_{MG} \times F_I = 92$ t C/ha (NIR, page 373);

(c) $SOC_{ref} = 92$ t C/ha, $F_{grassland} = F_{MG} = F_I = 1$.

89. To obtain $F_{forest\ land}$, Luxembourg uses the ratio between the average values for forest land (85 t C/ha) and grassland (92 t C/ha) from its national soil inventory, and consequently, $F_{forest\ land} = SOC_{forest\ land}/SOC_{ref} = 85/92 = 0.92$. The use of average values from a soil inventory is not in line with the IPCC good practice guidance for LULUCF. Indeed, when using country-specific values for stock change factor for land use or land-use change type (F_{LU}) (here $F_{forest\ land}$), the IPCC good practice guidance for LULUCF (page 3.130) states that "estimation of country-specific stock change factors for land-use conversion to grassland will typically be based on paired-plot comparisons representing converted and unconverted lands, where all factors other than land-use history are as similar as possible". The ERT noted that discarding the country-specific value of $F_{forest\ land}$ and reverting to the default value of 1 (IPCC good practice guidance for LULUCF, page 3.128) would result in a higher IEF than 0 t C/ha/year (zero). Therefore, the ERT considers that CO_2 emissions from deforestation are potentially underestimated and included this issue in the list of potential problems and further questions raised by the ERT during the review.

90. In its response to the list of potential problems and further questions raised by the ERT, Luxembourg submitted revised estimates on 17 November 2014 by:

(a) Calculating a specific IEF for each of the twelve land-use transitions and for each of the 10 soil types existing in Luxembourg ($12 \times 10 = 120$ IEFs) based on figures from a recently published study by Stevens et al. (2014);

(b) Calculating a weighted average IEF for each land-use transition based on the area of each soil type;

(c) Applying these IEFs to the area undergoing the relevant land-use transition.

91. This approach implicitly assumes that soil type is an acceptable proxy for "all factors other than land-use history", which the ERT considers reasonable given the relative homogeneity of climatic conditions in Luxembourg. It also implicitly assumes that afforestation and reforestation, and deforestation activities are homogeneously distributed

throughout Luxembourg, which was stated by Luxembourg during the review. For these reasons, the ERT considers that the revised estimates submitted on 17 November 2014 are in line with the IPCC good practice guidance for LULUCF and that the issue has been resolved. The ERT commends Luxembourg for this revision and recommends that the Party explain the revisions in its NIR.

2. Information on Kyoto Protocol units

92. Luxembourg has reported information on its accounting of Kyoto Protocol units in the required SEF tables, as required by decisions 15/CMP.1 and 14/CMP.1. The ERT took note of the findings and recommendations included in the SIAR on the SEF tables and the SEF comparison report.[12] The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10. The ERT reiterated the main findings and recommendations contained in the SIAR.

93. Information on the accounting of Kyoto Protocol units has been prepared and reported in accordance with decision 15/CMP.1, annex, chapter I.E, and reported in accordance with decision 14/CMP.1 using the SEF tables. This information is consistent with that contained in the national registry and with the records of the international transaction log (ITL) and the clean development mechanism registry and meets the requirements referred to in decision 22/CMP.1, annex, paragraph 88(a–j). The transactions of Kyoto Protocol units initiated by the national registry are in accordance with the requirements of the annex to decision 5/CMP.1 and the annex to decision 13/CMP.1. No discrepancy has been identified by the ITL and no non-replacement has occurred. The national registry has adequate procedures in place to minimize discrepancies.

Accounting of activities under Article 3, paragraph 3, of the Kyoto Protocol and any elected activities under Article 3, paragraph 4, of the Kyoto Protocol

94. Luxembourg has reported information on its accounting of KP-LULUCF in the accounting table, as included in the annex to decision 6/CMP.3. Information on the accounting of KP-LULUCF has been prepared and reported in accordance with decisions 16/CMP.1 and 6/CMP.3.

95. Table 7 shows the accounting quantities for KP-LULUCF as reported by Luxembourg and the final values after the review.

Table 7

Accounting quantities for activities under Article 3, paragraph 3, and, if any, activities under Article 3, paragraph 4, of the Kyoto Protocol, in t CO_2 eq

	2014 annual submission[a]		
	As reported	*Revised estimates*	*Final accounting quantity*[b]
Afforestation and reforestation			
Non-harvested land	–482 221	–606 405	–606 405
Harvested land	NO		NO
Deforestation	129 577	233 126	233 126

[12] The SEF comparison report is prepared by the international transaction log (ITL) administrator and provides information on the outcome of the comparison of data contained in the Party's SEF tables with corresponding records contained in the ITL.

	2014 annual submission[a]		
	As reported	*Revised estimates*	*Final accounting quantity*[b]
Forest management	NA		NA
Article 3.3 offset[c]	NA		NA
Forest management cap[d]	NA		NA
Cropland management	NA		NA
Grazing land management	NA		NA
Revegetation	NA		NA

Abbreviations: CRF = common reporting format, KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable, NO = not occurring.

[a] The values included under the 2014 annual submission are the cumulative accounting values for 2008, 2009, 2010, 2011 and 2012, as reported in the accounting table of the KP-LULUCF CRF tables for the inventory year 2012.

[b] The "final accounting quantity" is the quantity of Kyoto Protocol units that the Party shall issue or cancel under each activity under Article 3, paragraph 3, and paragraph 4, if relevant, based on the final accounting quantity in the 2014 annual submission.

[c] "Article 3.3 offset": for the first commitment period, a Party included in Annex I to the Convention that incurs a net source of emissions under the provisions of Article 3, paragraph 3, of the Kyoto Protocol may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

[d] In accordance with decision 16/CMP.1, annex, paragraph 11, for the first commitment period only, additions to and subtractions from the assigned amount of a Party resulting from forest management under Article 3, paragraph 4, of the Kyoto Protocol after the application of decision 16/CMP.1, annex, paragraph 10, and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

96. Based on the information provided in table 7 for the activity afforestation and reforestation, Luxembourg shall: for non-harvested land, issue 606,405 removal units (RMUs) in its national registry; for harvested land, neither issue nor cancel any units in its national registry.

97. Based on the information provided in table 7 for the activity deforestation, Luxembourg shall cancel 233,126 assigned amount units, emission reduction units, certified emission reduction units and/or RMUs in its national registry.

Calculation of the commitment period reserve

98. Luxembourg has reported its commitment period reserve in its 2014 annual submission. Luxembourg reported that its commitment period reserve has not changed since the initial report review (42,662,696 t CO_2 eq) as it is based on the assigned amount and not the most recently reviewed inventory (NIR, page 474). However, the ERT noted that while the result of the calculation of the commitment period reserve is correct, the calculation process is incorrect: Luxembourg has compared 90 per cent of the value of the assigned amount with five times the GHG emissions in 2011, but it should have compared it with five times the GHG emissions for 2012. The ERT recommends that the Party use the correct calculation process for the commitment period reserve and provide details in its NIR.

3. Changes to the national system

99. Luxembourg reported that there are no changes in its national system since the previous annual submission. The ERT concluded that Luxembourg's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.

4. Changes to the national registry

100. Luxembourg reported that there are changes in its national registry since the previous annual submission. Luxembourg described in its NIR the change to the database structure and the capacity of the national registry, the change regarding conformance to technical standards, the change to the list of publicly available information and the change regarding test results. The ERT concluded that, taking into account the confirmed changes in the national registry, Luxembourg's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP).

5. Minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol

101. Consistent with paragraph 23 of the annex to decision 15/CMP.1, Luxembourg provided information relating to how it is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement its commitments in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention.

102. Luxembourg notes that by implementing the features of the Kyoto Protocol, Luxembourg is working to minimize not only adverse effects of climate change but also any adverse effects due to the reduction of GHGs. Further, Luxembourg is strongly promoting long-term sustainable development, and notes in the NIR that it has reformed its energy markets to a large extent to reduce market imperfections.

103. Luxembourg reported that there are no changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, since the previous annual submission. The ERT concluded that the information provided continues to be complete and transparent.

III. Conclusions and recommendations

A. Conclusions

104. Table 8 summarizes the ERT's conclusions on the 2014 annual submission of Luxembourg, in accordance with the Article 8 review guidelines.

Table 8

Expert review team's conclusions on the 2014 annual submission of Luxembourg

Issue	*Expert review team assessment*	*Paragraph cross-references for identified problems*
The ERT concludes that the inventory submission of Luxembourg is complete with regard to categories, gases, years and geographical boundaries and contains both an NIR and CRF tables for 1990–2012		
Annex A sources[a]	Complete	
LULUCF[a]	Complete	
KP-LULUCF	Complete	
The ERT concludes that the inventory submission of Luxembourg has been prepared and reported in accordance with the UNFCCC reporting guidelines	Yes	Table 5, paragraph 31
Luxembourg's inventory is in accordance with the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF	Generally	Table 4, paragraphs 16, 40, 60 and 84
The submission of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1	Yes	98
Luxembourg has reported information on its accounting of Kyoto Protocol units in accordance with decision 15/CMP.1, annex, chapter I.E, and used the required reporting format tables as specified by decision 14/CMP.1	Yes	
The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1	Yes	
The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant CMP decisions	Yes	
Did Luxembourg provide information in the NIR on changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol?	Yes	

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, CMP = Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, CRF = common reporting format, ERT = expert review team, IPCC = Intergovernmental Panel on Climate Change, IPCC good practice guidance = IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, IPCC good practice guidance for LULUCF = IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use, land-use change and forestry, NIR = national inventory report, Revised 1996 IPCC Guidelines = *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, UNFCCC reporting guidelines = "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories".

[a] The assessment of completeness by the ERT considers only the completeness of reporting of mandatory categories (i.e. categories for which methods and default emission factors are provided in the Revised 1996 IPCC Guidelines, the IPCC good practice guidance or the IPCC good practice guidance for LULUCF).

B. Recommendations

105. The ERT identified the issues for improvement listed in table 9. All recommendations are for the next annual submission, unless otherwise specified. The ERT notes that this review report of the 2014 annual submission will be published after 15 April 2015. Where recommendations cannot be fully implemented in time for the 2015 annual submission, the ERT recommends that Luxembourg provide an update on progress of implementation in the NIR.

Table 9
Recommendations identified by the expert review team

Sector	*Category/cross-cutting issue*	*Recommendation*	*Reiteration of previous recommendation*	*Paragraph cross-references*
Cross-cutting	QA/QC	Address inconsistencies between the CRF tables and the NIR and improve the effectiveness of the QA/QC procedures	No	4
	Uncertainty analysis	Include all categories in the uncertainty analysis	Yes	16
	Uncertainty and key categories analysis	Include more detailed information on the uncertainty analysis and key category analysis in the NIR	Yes	20
Energy	Recalculations	Expand the recalculation sections within each category and subcategory to include values recalculated and the impact of the change, or include a cross-reference to the section in the NIR where recalculations are explained	Yes	25
	Navigation – CO_2, CH_4 and N_2O	Review the possible double counting of emissions from leisure boats	Yes	26
	Oil and natural gas – CH_4	Collect country-specific data for estimating CH_4 emissions from natural gas distribution	Yes	26
	Comparison of the reference approach with the sectoral approach and international statistics	Report and explain the differences between the reference and sectoral approaches, including the NCV used in the inventory and in the energy balance	No	28
		Continue the efforts to fix the problem related to the reporting of AD for emissions from lubricants as fuels in the reference approach	No	29
		Enter all fuels used in the country in the reference approach estimates and improve the QC procedures	Yes	30
	International bunker fuels	Describe transparently the methodology used to split national and international (bunker) fuel consumption to ensure that civil aviation emissions are accurately estimated	Yes	31

Sector	*Category/cross-cutting issue*	*Recommendation*	*Reiteration of previous recommendation*	*Paragraph cross-references*
		Report fuel consumption in marine bunkers and associated emissions in the CRF tables	No	32
	Feedstocks and non-energy use of fuels	Implement the planned improvement on the transparency of section 3.2.3.1 of the NIR by adding a table listing AD, carbon stored and emissions, as well as listing in which CRF category they are reported	No	33
	Road transportation: liquid fuels – N_2O	Incorporate relevant findings from the study on N_2O emissions for gasoline from road transportation	Yes	34
	Stationary combustion: liquid fuels – N_2O	Report emissions from off-road vehicles under the category mobile under other (fuel combustion) and clearly explain any reallocation and recalculation in the NIR	Yes	35
Industrial processes and solvent and other product use	Recalculations	Explain every recalculation in the NIR, and improve the QC procedures for the reporting of recalculations	No	38
	Time-series consistency	Revise the estimates of HFC emissions from foam blowing and SF_6 emissions from electrical equipment for 1990–1995 to ensure time-series consistency of these categories in accordance with the IPCC good practice guidance	No	40
	Consumption of halocarbons and SF_6 – HFCs, PFCs and SF_6	Report AD, IEF and emissions from refrigeration and air-conditioning equipment and noise reduction windows in CRF table 2(II).F to improve the consistency of the reporting	Yes	42
		Provide a more detailed explanation in the NIR of the methodologies and AD used to estimate SF_6 emissions from electrical equipment in order to increase the transparency of the reporting	Yes	43
		For potential PFC emissions, replace the notation key "NO" with either a value or the notation key "NE"	Yes	44
	Solvent and other product use – N_2O	Demonstrate the consistency of the time series or collect country-specific data for the entire time series for N_2O emissions	Yes	46
Agriculture	Manure management – CH_4 and N_2O	Describe the changes in the estimation of CH_4 emissions from manure management in the NIR	No	49
		Implement a higher-tier method for manure management from swine	Yes	50

Sector	*Category/cross-cutting issue*	*Recommendation*	*Reiteration of previous recommendation*	*Paragraph cross-references*
		Describe the changes in the estimation of Nex used for mature dairy cattle in the NIR	No	52
		Describe transparently the methodology to estimate N_2O emissions from agricultural soils in the NIR	No	54
LULUCF	Transparency	Improve the transparency of the reporting by providing references for the LULUCF and KP-LULUCF sectors in a systematic and comprehensive manner in the NIR	Yes	58
	QA/QC	Improve the QC procedures, in particular regarding references for EFs and AD, and regarding consistency between the NIR and the CRF tables	Yes	59
	Uncertainty analysis	Report the uncertainty analysis for LULUCF in accordance with the IPCC good practice guidance for LULUCF and transparently describe the method used to estimate the uncertainty	No	60
	Forest land remaining forest land – CO_2	Reproduce the entire time series of harvest statistics, provide an explanation for the inconsistency between harvesting trends and carbon stock changes in living biomass and investigate the discrepancy between STATEC and FAOSTAT data on harvest	No	61
		Use the results from the second NFI to recalculate the emission/removal estimates from forest land remaining forest land and all categories involving forest land	Yes	62
	Land converted to forest land – CO_2	Describe transparently the planned improvements to estimate the increment and harvest for species other than beech, oak, spruce and Douglas fir	No	64
		Include clarification on the method for calculating carbon stock changes for conversions to forest land from wetlands, settlements and other land in the NIR	No	65
	Land converted to grassland – CO_2	Report on the results of the investigation into the accuracy of the 2000–2007 values of the areas in view of the new AD for 2008–2012, paying particular attention to areas that may have undergone a back-and-forth classification from and to forest land	No	66
		Report all areas of cropland converted to grassland in the category land converted to grassland	No	67

Sector	*Category/cross-cutting issue*	*Recommendation*	*Reiteration of previous recommendation*	*Paragraph cross-references*
	Cropland remaining cropland – CO_2	Correct the NIR to ensure consistency between the NIR and the CRF tables	No	68
	Direct N_2O emissions from nitrogen fertilization of forest land and other – N_2O	Explain explicitly in the NIR that forest fertilization does not occur	No	71
	Biomass burning – CH_4 and N_2O	Explain explicitly in the NIR that the practice of biomass burning does not occur on cropland and grassland	No	72
Waste	Solid waste disposal on land – CH_4	Assess whether the assumption of the 90 per cent reduction for the methane correction factor is valid for the Party's national circumstances and provide the results of this assessment	No	75
	Wastewater handling – N_2O	Review the N_2O EF for plants with significant denitrification and use a consistent methodology to estimate these emissions	No	77
		Review the estimations from all discharges of wastewater, including those from wastewater plants, to confirm that all N_2O emissions are estimated	No	78
		Take into account the N removed in the sludge spread on agricultural fields when estimating the N_2O emissions from wastewater in order to avoid double counting; revise the method to estimate N_2O emissions from wastewater handling, taking into account all the inconsistencies and omissions	No	79
Activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol	Transparency	Improve the transparency of the reporting by including the explanation on species mix estimation in the NIR	No	83
	Key categories	Classify afforestation and reforestation, and deforestation as key categories according to the IPCC good practice guidance for LULUCF	No	84
	Carbon stock changes in below-ground biomass and litter	Report separately carbon stock changes in below-ground biomass and litter for the KP-LULUCF categories	Yes	85

Sector	*Category/cross-cutting issue*	*Recommendation*	*Reiteration of previous recommendation*	*Paragraph cross-references*
	Afforestation and reforestation – CO_2	Improve the transparency of the reporting under the Kyoto Protocol and separately report the carbon stock changes for the living biomass pools (above-ground and below-ground) using the information already available within the national inventory system	Yes	86
	Deforestation – CO_2	Explain the revisions in the estimation of changes in mineral SOC stock in deforestation resulting from the conversion of forest to grassland	No	91
Calculation of the commitment period reserve		Use the correct calculation process for the commitment period reserve and provide details in the NIR	No	98
General		Provide an update on progress of implementation of the recommendations in the NIR	No	105

Abbreviations: AD = activity data, CRF = common reporting format, EF = emission factor, FAOSTAT = database of the Food and Agriculture Organization of the United Nations, IEF = implied emission factors, IPCC = Intergovernmental Panel on Climate Change, IPCC good practice guidance for LULUCF = IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use, land-use change and forestry, N = nitrogen, NCV = net calorific values, Nex = nitrogen excretion, NIR = national inventory report, NE = not estimated, NFI = national forest inventory, NO = not occurring, QA/QC = quality assurance/quality control, SOC = soil organic carbon, STATEC = national statistics.

IV. Questions of implementation

106. No questions of implementation were identified by the ERT during the review.

Annex I

Information to be included in the compilation and accounting database

Table 10
Information to be included in the compilation and accounting database in t CO_2 eq for 2012, including the commitment period reserve

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Commitment period reserve	42 662 696			42 662 696
Annex A emissions for 2012				
CO_2	10 870 108			10 870 108
CH_4	422 671	427 121		427 121
N_2O	470 892	465 389		465 389
HFCs	67 262			67 262
PFCs	164			164
SF_6	8 143			8 143
Total Annex A sources[c]	**11 839 241**	**11 838 188**		**11 838 188**
Activities under Article 3, paragraph 3, for 2012				
3.3 Afforestation and reforestation on non-harvested land for 2012	–122 868	–143 963		–143 963
3.3 Afforestation and reforestation on harvested land for 2012	NO			NO
3.3 Deforestation for 2012	24 699	43 060		43 060
Activities under Article 3, paragraph 4, for 2012[d]				
3.4 Forest management for 2012				
3.4 Cropland management for 2012				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2012				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2012				
3.4 Revegetation for the base year				

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustments.
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] The values for "Total Annex A sources" in the columns "As reported", "Revised estimates" and "Final" may not equal the sum of the values for the gases in those columns owing to rounding.
[d] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 11
Information to be included in the compilation and accounting database in t CO_2 eq for 2011

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2011				
CO_2	11 138 341			11 138 341
CH_4	429 761	434 149		434 149
N_2O	481 879	480 680		480 680
HFCs	67 013			67 013
PFCs	180			180
SF_6	7 754			7 754
Total Annex A sources[c]	**12 124 928**	**12 128 117**		**12 128 117**
Activities under Article 3, paragraph 3, for 2011				
3.3 Afforestation and reforestation on non–harvested land for 2011	–108 223	–131 415		–131 415
3.3 Afforestation and reforestation on harvested land for 2011	NO			NO
3.3 Deforestation for 2011	25 387	45 069		45 069
Activities under Article 3, paragraph 4, for 2011[d]				
3.4 Forest management for 2011				
3.4 Cropland management for 2011				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2011				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2011				
3.4 Revegetation for the base year				

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, NO = not occurring.

[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustments.

[b] "Final" includes revised estimates, if any, and/or adjustments, if any.

[c] The values for "Total Annex A sources" in the columns "As reported", "Revised estimates" and "Final" may not equal the sum of the values for the gases in those columns owing to rounding.

[d] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 12
Information to be included in the compilation and accounting database in t CO_2 eq for 2010

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2010				
CO_2	11 255 139			11 255 139
CH_4	446 688	451 068		451 068
N_2O	473 675	480 216		480 216
HFCs	66 471			66 471
PFCs	198			198
SF_6	7 390			7 390
Total Annex A sources[c]	**12 249 560**	**12 260 481**		**12 260 481**
Activities under Article 3, paragraph 3, for 2010				
3.3 Afforestation and reforestation on non-harvested land for 2010	–93 579	–118 867		–118 867
3.3 Afforestation and reforestation on harvested land for 2010	NO			NO
3.3 Deforestation for 2010	26 074	47 077		47 077
Activities under Article 3, paragraph 4, for 2010[d]				
3.4 Forest management for 2010				
3.4 Cropland management for 2010				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2010				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2010				
3.4 Revegetation for the base year				

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, NO = not occurring.

[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustments.

[b] "Final" includes revised estimates, if any, and/or adjustments, if any.

[c] The values for "Total Annex A sources" in the columns "As reported", "Revised estimates" and "Final" may not equal the sum of the values for the gases in those columns owing to rounding.

[d] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 13
Information to be included in the compilation and accounting database in t CO_2 eq for 2009

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2009				
CO_2	10 703 315			10 703 315
CH_4	440 034	444 337		444 337
N_2O	467 814	469 580		469 580
HFCs	65 466			65 466
PFCs	218			218
SF_6	6 999			6 999
Total Annex A sources[c]	**11 683 847**	**11 689 916**		**11 689 916**
Activities under Article 3, paragraph 3, for 2009				
3.3 Afforestation and reforestation on non-harvested land for 2009	–78 934	–106 319		–106 319
3.3 Afforestation and reforestation on harvested land for 2009	NO			NO
3.3 Deforestation for 2009	26 762	49 086		49 086
Activities under Article 3, paragraph 4, for 2009[d]				
3.4 Forest management for 2009				
3.4 Cropland management for 2009				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2009				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2009				
3.4 Revegetation for the base year				

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, NO = not occurring.

[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustments.

[b] "Final" includes revised estimates, if any, and/or adjustments, if any.

[c] The values for "Total Annex A sources" in the columns "As reported", "Revised estimates" and "Final" may not equal the sum of the values for the gases in those columns owing to rounding.

[d] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 14
Information to be included in the compilation and accounting database in t CO_2 eq for 2008

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2008				
CO_2	11 207 202			11 207 202
CH_4	442 569	446 762		446 762
N_2O	468 358	475 193		475 193
HFCs	63 460			63 460
PFCs	242			242
SF_6	6 571			6 571
Total Annex A sources[c]	**12 188 402**	**12 199 430**		**12 199 430**
Activities under Article 3, paragraph 3, for 2008				
3.3 Afforestation and reforestation on non-harvested land for 2008	–78 616	–105 841		–105 841
3.3 Afforestation and reforestation on harvested land for 2008	NO			NO
3.3 Deforestation for 2008	26 654	48 834		48 834
Activities under Article 3, paragraph 4, for 2008[d]				
3.4 Forest management for 2008				
3.4 Cropland management for 2008				
3.4 Cropland management for the base year				
3.4 Grazing land management for 2008				
3.4 Grazing land management for the base year				
3.4 Revegetation for 2008				
3.4 Revegetation for the base year				

Abbreviations: Annex A sources = source categories included in Annex A to the Kyoto Protocol, NO = not occurring.

[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustments.

[b] "Final" includes revised estimates, if any, and/or adjustments, if any.

[c] The values for "Total Annex A sources" in the columns "As reported", "Revised estimates" and "Final" may not equal the sum of the values for the gases in those columns owing to rounding.

[d] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Annex II

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>.

Intergovernmental Panel on Climate Change. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Available at <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

"Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories". FCCC/SBSTA/2006/9. Available at <http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>.

"Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention". FCCC/CP/2002/8. Available at <http://unfccc.int/resource/docs/cop8/08.pdf>.

"Guidelines for national systems for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, paragraph 1, of the Kyoto Protocol". Decision 19/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=14>.

"Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol". Decision 15/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>.

"Guidelines for review under Article 8 of the Kyoto Protocol". Decision 22/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>.

Status report for Luxembourg 2014. Available at <http://unfccc.int/resource/docs/2014/asr/lux.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2014. Available at <http://unfccc.int/resource/webdocs/sai/2014.pdf>.

FCCC/ARR/2013/LUX. Report of the individual review of the annual submission of Luxembourg submitted in 2013. Available at <http://unfccc.int/resource/docs/2014/arr/lux.pdf>.

Standard independent assessment report template, parts 1 and 2. Available at <http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php>.

B. Additional information provided by Luxembourg

Responses to questions during the review were received from Mr. Marc Schuman (Environment Agency), including additional material on the methodology and assumptions used. The following documents[1] were also provided by Luxembourg:

Gruber L and Pötsch EM. 2006. Calculation of nitrogen excretion of dairy cows in Austria. *Die Bodenkultur*. 57(2): pp. 65–72.

Steinwidder A and Guggenberger T. 2003. Erhebungen zur Futteraufnahme und Nährstoffversorgung von Milchkühen sowie Nährstoffbilanzierung auf Grünlandbetrieben in Österreich. [Investigations on feed intake and nutrient supply of dairy cows as well as nutrient balance studies on farms in grassland regions of Austria]. *Die Bodenkultur*. 54(1): pp. 49–66.

Stevens A, van Wesemael B, Marx S and Leydet L. 2014. *Mapping Topsoil Organic Carbon Stocks in Grand-Duchy of Luxembourg*. Catholic University of Louvain (Belgium) and Luxembourg's Ministry of Agriculture, Wine Production and Consumer Protection. 16 pp.

[1] Reproduced as received from Luxembourg.

Annex III

Acronyms and abbreviations

AD	activity data
AWMS	animal waste management system
C	carbon
CH_4	methane
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CRF	common reporting format
EF	emission factor
ERT	expert review team
EU	European Union
FAOSTAT	database of the Food and Agriculture Organization of the United Nations
$Frac_{GASF}$	the fraction of synthetic fertilizer nitrogen applied to soils that volatilizes as ammonia and nitrogen oxides
$Frac_{GASM}$	the fraction of livestock nitrogen excretion that volatilizes as ammonia and nitrogen oxides
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 without GHG emissions and removals from LULUCF
HFCs	hydrofluorocarbons
IE	included elsewhere
IEA	International Energy Agency
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
ITL	international transaction log
kg	kilogram (1 kg = 1,000 grams)
kha	kilohectare
KP-LULUCF	land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
LULUCF	land use, land-use change and forestry
MB	mechanical–biological
MCF	methane conversion factor
Mg	megagram (1 Mg = 1 tonne)
N_2O	nitrous oxide
N	nitrogen
NA	not applicable
NCV	net calorific value
NE	not estimated
Nex	nitrogen excretion
NFI	national forest inventory
NIR	national inventory report
NO	not occurring
PFCs	perfluorocarbons
PJ	petajoule (1 PJ = 10^{15} joule)
QA/QC	quality assurance/quality control
RMU	removal unit
SEF	standard electronic format
SF_6	sulphur hexafluoride
SIAR	standard independent assessment report

SOC	soil organic carbon
STATEC	national statistics
SWDS	solid waste disposal sites
TJ	terajoule (1 TJ = 10^{12} joule)
UNFCCC	United Nations Framework Convention on Climate Change